Universidad Zaragoza

Academic Year/course: 2022/23

66100 - Fundamental Properties of Nanostructured Materials

Syllabus Information

Academic Year: 2022/23
Subject: 66100 - Fundamental Properties of Nanostructured Materials
Faculty / School: 100 - Facultad de Ciencias
Degree: 539 - Master's in Nanostructured Materials for Nanotechnology Applications
ECTS: 6.0
Year: 1
Semester: First semester
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The main aim of this course is to provide students with a sound theoretical and methodological background that will allow them to understand the fundamentals of the chemistry, physics, materials science, biochemistry, engineering, bioengineering and ecotoxicity behind the properties of nanomaterials. This knowledge will guide students in the following modules of the Master.

These approaches and objectives are aligned with the following Sustainable Development Goals (SDG) of the Agenda 2030 of the United Nations (https://www.un.org/sustainabledevelopment/es/), in such a way that the acquisition of learning outcomes of the subject provides training and competence to contribute to some extent to the achievement of O9. Industry, innovation and infrastructures. More specifically, they will create action to enhance research, foster innovation and upgrade industrial technologies.

1.2. Context and importance of this course in the degree

Advances in Nanoscience are expected to result in drastic changes in our understanding of the design and fabrication of nanodevices which will make use of the exceptional properties of nanomaterials. In this context, it is believed that Nanotechnology will be, if it is not yet, the 21st century revolution due to the numerous societal implications of Nanoscience and applications in daily life (food, textiles, vehicles, nanodiagnosis, nanocure, etc.).

On atomic- and molecular-scale - known as nanoscale - there is a convergence between Physics, Chemistry, Biochemistry, Science of Materials, Engineering and Bioengineering towards the same theoretical principles and experimental techniques.

This first course of the master covers the basic concepts of these disciplines so that students understand and take in the more advanced information to be studied in later modules. Throughout this module, students wil be given the tools to identify the potential of working at the nanoscale involving a large variety of disciplines including nanophysics, nanochemistry, and nanobiomedicine; and will acquire skills to interrelate structure, composition, architecture and physical, chemical properties of nanomaterials.

1.3. Recommendations to take this course

The ?*Fundamental Properties of Nanostructured Materials*? module is obligatory and equivalent to 6 ECTS credits or 150 student work hours. The course is given in the first term of the academic year.

The objective of this module is to introduce the student to state of the art Nanoscience and Nanotechnology, highlighting their multi-discipline nature as well as their scientific, social, economic and legal implications.

Therefore, it is an introductory module that provides prior preparation for students to assimilate and correlate the contents of the successive modules that, sequentially, will train the student in the synthesis, processing and characterization of nanostructured materials so that they will, in turn, be able to design and plan nanodevices with marketplace applications.

The proposed aims of this course are crucial to provide students with a sound theoretical and methodological background that will allow them to understand the concepts presented in the subsequent subjects of the master successfully.

As the whole course is taught in English, students need to have an upper-intermediate level in the language: minimum level B1 in the European Common Framework Language Reference, but preferably level B2. Level B1 is reached when the student is able to understand the main points of clear, standard-language texts when covering known matters - whether in terms of work, study or leisure; when able to cope in most situations which the student encounters during a trip to places where the language is spoken; when able to write simple, coherent texts on familiar topics or those in which the student has an interest; and when able to describe experiences, happenings, wishes and ambitions as well as briefly justify opinions or

explain plans. B2 is achieved when the student is able to understand the main ideas of complex texts that deal with both specific and abstract topics, even if these are technical - though within the field of specialisation; when able to communicate with native speakers with the degree of fluency and ease such that the communication takes place without effort on either side; and when able to write clear, detailed texts on diverse subjects as well as defend a point of view on general topics - giving the pros and cons of the different options.

2. Learning goals

2.1. Competences

After completing the course, the student will be competent in the following skills:

- Understanding the state of art of Nanoscience and Nanotechnology, assessing its multidisciplinary nature as well as the social, economic and legal implications.

- Understanding the conceptual differences between macro and nano systems, obtaining the necessary theoretical knowledge to acquire understanding of the nanoscale.

- Identifying materials and compounds of significant relevance at the nanoscale, evaluating the state of the art and recognizing the unresolved issues.

- Understanding the importance of the surface effects and the new forces that appear on the nanoscale and their influence on the properties of nanoscopic systems.

- Assessing properties of particular interest in nanostructured materials.

- Applying acquired knowledge to properly handle nanostructued materials. Students are expected to know the possible effects of nanomaterials on health, environment and sustainability.

2.2. Learning goals

The student, in order to pass the course, will have to show her/his competence in the following skills:

- Recognise materials and compounds of particular relevance on the nanoscale, noting the degree of advance achieved and the problems still to be solved.

- Distinguish between macro, micro and nano systems; identify the physical and chemical tools necessary to work on the nanoscale.

- Understand the toxic potential and possible effects of nanomaterials on health, environment and sustainability.

- Identify the scientific and technological possibilities of nanostructured materials: on the one hand, assessing social interest for miniature devices and the new and revolutionary applications for these; on the other hand, recognising the existence of a new scientific and technological context governed by nanoscale laws - the Laws of Quantum Mechanics.

2.3. Importance of learning goals

The enormous potential of Nanoscience and Nanotechnology has caught on deeply in politicians, businessmen and society itself creating new demands for specialists at the very highest level in the field. Therefore, a prime objective of this Master is the creation of professionals with the understanding, knowledge and abilities necessary to exercise as senior professionals in diverse areas (industry - production of new materials, electronics industry, pharmaceuticals, chemistry, aerospace, etc. ? consultancy, research, teaching, etc.).

In the context of this Master, the ?*Fundamental Properties of Nanostructured Materials*? module aims to make the student aware of the relevance of Nanoscience and Nanotechnology in the scientific and technological atmosphere of 21st century society. The student will gain the essential tools necessary to be able to study in depth all areas corresponding to the design and creation of new and efficient nanodevices, covering synthesis, processing, characterization and property determination for these devices. At the same time, the student will assess other areas such as sustainability, safety, financial benefits, etc.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student will prove that he/she has achieved the expected learning results by means of the following assessment tasks.

For students choosing **Continuous Assessment** (attendance to at least 80% of this module lectures is required):

1.- Written exam (50% of the final result for the module). With this exam the students are expected to demonstrate that they have assimilated the critical approaches presented by their lectures, are able to explain with their own words the acquired knowledge, and are capable to prove their ability to resolve problems of interest of Nanoscience and Nanotechnology. Plagiarism (the illicit copying of another person's work, especially written content, for presentation as one's own) is not allowed.

The exam will credit students? achievement of these module competences. This written exam consists of:

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(a) Theory questions including: (i) topic(s) to be explained and (ii) short answer and/or multiple choice questions. On a scale of 1 to 10, this written test will assess the knowledge of the student regarding the state of the art in Nanoscience/Nanotechnology; electrical, magnetic, optical and mechanical properties of nanomaterials; links between the structure and chemical composition of nanostructured materials and importance of surface effects.

(b) The exam will also contain a section on problem solving and exercises where - on a scale of 1 to 10 ? data treatment ability, chemical-physical property assessment, differentiation between macro- and nanoscale, use of appropriate SI units, etc. will be assessed.

2.- Exercise, problem and question solving of matters seen in class and seminars, where the students need to show knowledge of the topic and oral communication skills (50% of the final result of the module). Through these tests, the results of the learning process will be assessed with regard to the abilities required for the module such as data interpretation, oral and written communication skills, interaction with colleagues and professionals from other areas, etc.

A minimum qualification of 4 out of 10 is needed in each of the two tasks to pass the subject. In any case, the average over the two sections must be at least 5 out of 10 to pass the subject.

For students that did not pass the ongoing assessment or wish to increase their mark, the **Global Assessment** comprises:

A written test (50%) and an oral test (50%) before a board of three lecturers from the subject area. In these tests, the student must display knowledge of the topics taught in this module as well as their ability to apply this knowledge to specific problems and situations showing good use of the units system, correct treatment and interpretation of experimental data, eco-toxicity, etc... Plagiarism (the illicit copying of another person's work, especially written content, for presentation as one's own) is not allowed.

Scientific communication skills will also be evaluated through these tests - on a scale of 1 to 10 - and here correct use of scientific language, audiovisual techniques, graphics, clarity of presentation, etc. will be expected.

Both oral and written exams will take place in the language used for the course: English. A minimum qualification of 4 out of 10 is needed in each of the two parts of the exam to pass the subject. In any case, the average over the two sections must be at least 5 out of 10 to pass the subject.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The aim of this course is to establish the basic principles of Physics, Chemistry, Biology, Science of Materials, Engineering, Bioengineering and Eco-toxicity necessary to successfully tackle the following courses which have an eminently applied nature. Therefore, following a general examination of these basic principles through participatory master classes, there will be case and problem analysis activities where these principles can be observed, examined in depth, evaluated and clarified.

The methodology followed in this course is oriented towards achievement of the learning objectives. Students are expected to participate actively in the class throught the semester.

Classroom materials will be available via Moodle. These include a repository of the lecture notes used in class, the course syllabus, as well as other course-specific learning materials.

Further information regarding the course will be provided by the coordinator of the course on the first day of class.

4.2. Learning tasks

This is a 6 ECTS course organized as follows:

? **Lectures**. Lecture notes and a set of problems (and their corresponding solutions) will be available for the students. Each topic area making up the programme for the course will be presented, analysed and discussed by the lecturer through lectures of 50 minutes. The lecturers will provide the students with notes, handouts or summaries of class content prior to the beginning of the class (preferably via Moodle) along with the recommended reading for more in-depth understanding of the topic. Additionally, open forum activities on the basic concepts and their application, comparison with real developments, problem-solving and practical case studies are included in this module.

? **Assignments**. At the end of every topic, each student will complete the Q&As that the lecturers give them over the course. The Q&As are to be completed individually by students and sent electronically or handed in to the lecturers. In some cases, the Q&As will be presented and openly debated during class. Here, the students must also show their oral communication skills. Students will receive a reply from the lecturers as a result of the Q&As and there will be a discussion on the areas of discrepancy in the answers. For some topics, the assignments will be carried out in small groups or in pairs, and the students will elaborate an oral exposition for the presentation to the class.

? **Autonomous work**. Students are expected to spend about 90 hours to study theory, solve problems, prepare sessions and assignments and take exams.

Note: The teaching and evaluation activities will be carried out in person unless, due to COVID-19, the provisions issued by the competent authorities and by the University of Zaragoza oblige to carry out virtually.

4.3. Syllabus

The course will address the following topics:

- Nanomaterials vs. macroscopic materials
- Physical Chemistry at the Nanoscale
- Physical Chemistry of Surfaces
- Introduction to Supramolecular Chemistry and Self-Assembly
- Optical, electric, magnetic, and mechanical properties of nanomaterials
- Nanoscopic organic materials (nanotubes, fullerenes, dendrimers, block copolymers...).
- 2D Nanomaterials
- Nanobiomaterials. Biomacromolecules.
- Nanoporous materials (zeolites and related, MOFs and mesoporous silica): structure, properties and emerging applications
- Eco-nanotoxicology

4.4. Course planning and calendar

The course is given in the afternoon and the calendar for classes and exam dates will be published prior to the beginning of each academic year in the web site of the Faculty of Science. Furthermore, the google calendar for this course will be shared with the students for a more efficient and effective communication.

The course lasts approximately 4-5 weeks and begins at the start of the academic year (the first fortnight of September).

Further information concerning the timetable, classroom, assessment dates and other details regarding this course, will be provided on the first day of class by the coordinator of the course.

Additionally, the student can set up regular appointments for office hour consultation.